SEISMIC NETWORK OPERATIONS IN ALASKA

Annual Project Summary

October 01, 2003 - September 30, 2004

External Grant Award Number 04HQAG0120

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Program Element II. Research on Earthquake Occurrence and Effects

Key Words: Wave Propagation, Regional Seismic Hazards and Real-time earthquake information

Non-Technical Summary

AEIC and AVO jointly operate, record and analyze data from ~800 channels of seismic data throughout Alaska. Part of the operation and maintenance of the network is supported by USGS/NEHRP. The real-time network contains numerous short-period seismic stations, 37 accelerometers, 57 broadband stations, and the associated receiving and telemetry systems. Many of these stations are in remote areas with extreme climatic conditions and can only be reached by helicopter, after the snow has melted. The major thrust of this work is to provide continued operation of the south Alaska seismic network together with the routine analysis of the combined network data.

Investigations Undertaken

The Alaska Earthquake Information Center (AEIC) and Alaska Volcano Observatory (AVO) jointly operate, record and analyze data from several networks comprising about 800 channels of seismic data throughout Alaska. Part of the operation and maintenance of the network is supported by USGS/NEHRP.

The USGS/NEHRP funded network contains numerous short-period (SP) seismic stations, 13 Strong motion accelerometers (SMA) and the associated receiving and telemetry systems. Many of these stations are in very remote areas with extreme climatic conditions and can only be reached by helicopter, late in the summer after the snow has melted. The SMAs are designed with a two-year routine site visit schedule, nine were serviced in summer of 2003 and three in the summer of 2004. The SP stations have varying maintenance schedules from two to five years or more depending upon power source, and equipment failures. Throughout the contract period, all sites were serviced to repair improperly functioning equipment.

We now have a total of 57 broadband digital stations operating in Alaska. Three of these are IRIS stations, fifteen are installed by AVO on volcanoes, five are operated by WC/ATWC, and the rest were installed by AEIC.

Seismicity

For the period from October 1, 2003 to September 30, 2004 the AEIC located a total of 27,738 events within the combined seismic network. The seismicity in the western Aleutian arc and Bering sea is supplemented by teleseismic locations in cooperation with NEIC. A map of these events is shown in Figure 1. Figure 2a shows seismicity in the south-central Alaska with two cross-sections presented in Figure 2b. There were 469 events with magnitude 4.0 or above (~40 events per month on average) and 47 events with magnitude 5.0 or above (~4 events per month on average). The largest earthquake occurred on November 17, 2003 in the Rat Islands region of Aleutian Islands (M_W 7.8). The AEIC located ~6,750 aftershocks of the 2002 M_W 7.9 Denali Fault earthquake within this time interval (~560 per month, the largest aftershock M_L=4.8). The cumulative number of processed events is shown in Figure 3. Figure 4 illustrates the frequency-magnitude relation for the earthquakes located in the mainland Alaska. From this relation, the magnitude of completeness of the AEIC catalog for this time period within the network core area is estimated to be 1.4.

Earthquake Sources

The AEIC routinely determines P-wave first motion focal mechanisms for earthquakes with M_L>=3.5 located within the network core area. There are 127 first motion focal mechanisms for this time period; the largest event is M_L=5.9 in the Cook Inlet region, the deepest event is at 224 km depth in the Alaska Peninsula region (see map in Figure 5a). Regional seismic moment tensors are determined for earthquakes with M_W>= 3.8 in the mainland Alaska and M_W>=4.0 in the Aleutians. The AEIC determined a total of 61 moment tensors for this time period with the largest event a M_W=6.7 in the Queen Charlotte Islands region (see map in Figure 5b).

During the contract period, the Alaska Earthquake Information Center has released the following documents and publications on a regular basis:

Weekly Seismicity Reports

Weekly reports include summary listings of all located earthquakes in or near Alaska for the previous week (500 events per week on average for this time period), with date and time of origin, latitude, longitude and hypocentral depth, magnitude, solution quality parameters and a brief comment regarding approximate region, alternate magnitudes and any felt information. Each weekly listing also includes an epicenter map of the whole state (including the Aleutian Islands), a close-up map focusing on the central and south-central part of the state which is most heavily populated, and a brief verbal summary of largest or most significant earthquakes to have occurred during the week. The seismicity maps and earthquake summary are available over the Worldwide Web, updated on a weekly basis.

Monthly Earthquake Catalogs

Approximately four months after the end of each month, AEIC issues "Earthquakes in Alaska," a monthly catalog of earthquakes in and near Alaska. The catalogs include full-state seismicity maps, south-central seismicity maps, cross-sections through the two Wadati-Benioff Zones which exist beneath Alaska, a comprehensive listing of the month's earthquakes with additions from the National Earthquake Information Center, the Pacific Coast and Alaska Tsunami Warning Center, and data from the Geological Survey of Canada where appropriate. A "Highlights" section discusses in detail several of the month's most interesting or significant earthquakes, each of which is presented with an individual map and, when available, its focal mechanism. Detected and located mine and quarry blasts are also itemized in the monthly catalogs.

Information Releases

As a part of the 24-hour earthquake monitoring carried out by AEIC, any earthquake whose magnitude is large enough to be considered significant (M>=3.5 in the mainland Alaska and M>=4.0 in the Aleutian), or an earthquake which was felt by locals, will have a formal "Information Release" issued. The Information release is sent out in two forms: electronic mail is broadcast to a suite of recipients, with a text message providing location, magnitude and any other pertinent information; also, a FAX release is transmitted which includes all the above information as well as a map illustrating the epicenter of the earthquake. These email and FAX releases are sent to numerous state, local and federal government agencies, news media, utilities, other seismic observatories and interested parties. In addition, all Information Releases are now available on the Web.

ANSS Catalog contribution

We have implemented regular submission of our earthquake catalogs to the ANSS system at UC Berkeley. Catalogs are submitted several days after completion of each month. In addition, we have retroactively submitted all catalogs from July 1988 until present, meaning that the catalogs from the full period of this grant have been submitted to the ANSS.

Outreach and Education

During the contract period, seismologists provided an average of two invited lectures each month to various audiences including University departments, community organizations such as the Rotary and Kiwanis clubs, meetings of engineers and public safety officials as well as guest lectures at area elementary and high schools. Among these were two heavily attended (200 people) lectures given in Fairbanks and Anchorage as part of the annual "Science for Everyone" public lecture series, and one as a regular part of the State Division of Emergency Services continuing education class for teachers, "Quake and Shake." Several television news appearances and taped radio interviews were made during the year. AEIC participated in Earth Day activities with an earthquake booth, providing educational demonstrations and materials on earthquakes and earthquake preparedness. An earthquake and seismology booth was set up and maintained during the Tanana Valley State Fair; this was heavily attended and much literature was disbursed regarding earthquakes and earthquake preparedness.

Tours are routinely conducted in the seismology laboratory; on average, two groups per week are provided with lab tours and talks; these groups range from emergency providers and visiting professionals to tourists and school children.

AEIC routinely exchanges e-mail with citizens worldwide who are seeking information about Alaska earthquakes, or seismology in general, and has provided verbiage and graphics for engineering reports, newspaper articles and school textbooks this year. Public Radio International's "Earth and Sky" series has contacted us on three occasions for help in crafting responses to their listeners' questions about earthquakes.

Public schools throughout the state of Alaska are beginning to incorporate seismology into their science curriculum through their access to our data via the Internet. Further, we are working closely with selected schools to maintain seismic instruments at their location and encourage hands-on participation among students and teachers in the routine scanning and transfer of seismic data; our efforts are modeled on our participation with the Princeton Earth Physics Project (PEPP) approach for bringing schools into the seismic network both as a means to enhance science and mathematics education, as well as to augment our own network coverage and capabilities.

We have a Web page for the Seismology group at the Geophysical Institute that incorporates the activities of the ASN and the AEIC. Within this web site are descriptions of personnel, network topology, network processing, earthquake occurrence, research activities, and links to a variety of related sites. Examples of related links include the USGS Alaska Hazard Maps, publications on hazard preparedness, and a customized version of the Community Internet Intensity Map (CIIM) in collaboration with David Wald. In addition, we are supplying near-real-time earthquake information to both the CIIM and the web based seismicity maps through the QDDS system. We have implemented dbrecenteqs, a web-based application to display detected earthquakes on the web as they are detected in near-real-time.

Significant events: The M_W 7.8 Rat Islands Earthquake of November 17, 2003

At 9:43 p.m. AST (06:43 11/17 UTC) on Sunday evening, November 16, 2003, a major earthquake (M_W=7.8, CMT) occurred in the Rat Islands region of the Aleutian Islands. This earthquake was situated 95 kilometers (59 miles) south-southwest of Amchitka. It was the largest event to occur in North America since the magnitude 7.9 Denali Fault, Alaska earthquake of November 3, 2002, and the largest in the Aleutian Islands since the June 1996 magnitude 7.9 Adak earthquake. The AEIC located over 600 aftershocks of the M7.8 event through the end of the reported time period. The magnitude of completeness of the aftershock catalog is 3.5. The largest aftershock occurred at 10:50 p.m. AST on November 17 (7:50 UTC, 11/18) and had a moment magnitude of 5.7. The main shock generated a small tsunami of about 50 cm (1.64 ft) at Shemya and 12 cm (0.39 ft) at Adak (Alaska Tsunami Warning Center).

The M 7.8 earthquake occurred on the convergent boundary between the subducting Pacific and overriding North American crustal plates. This region, where the two plates are being forced directly into one another, is one of the world's most active seismic zones. Over one hundred earthquakes of magnitude seven or larger have occurred along this boundary in the past hundred years. The 1965 M 8.7 Rat Islands earthquake ruptured an ~600 km-long portion of the plate boundary. In the 2003 M7.8 earthquake, the easternmost part of the 1965 zone failed again.

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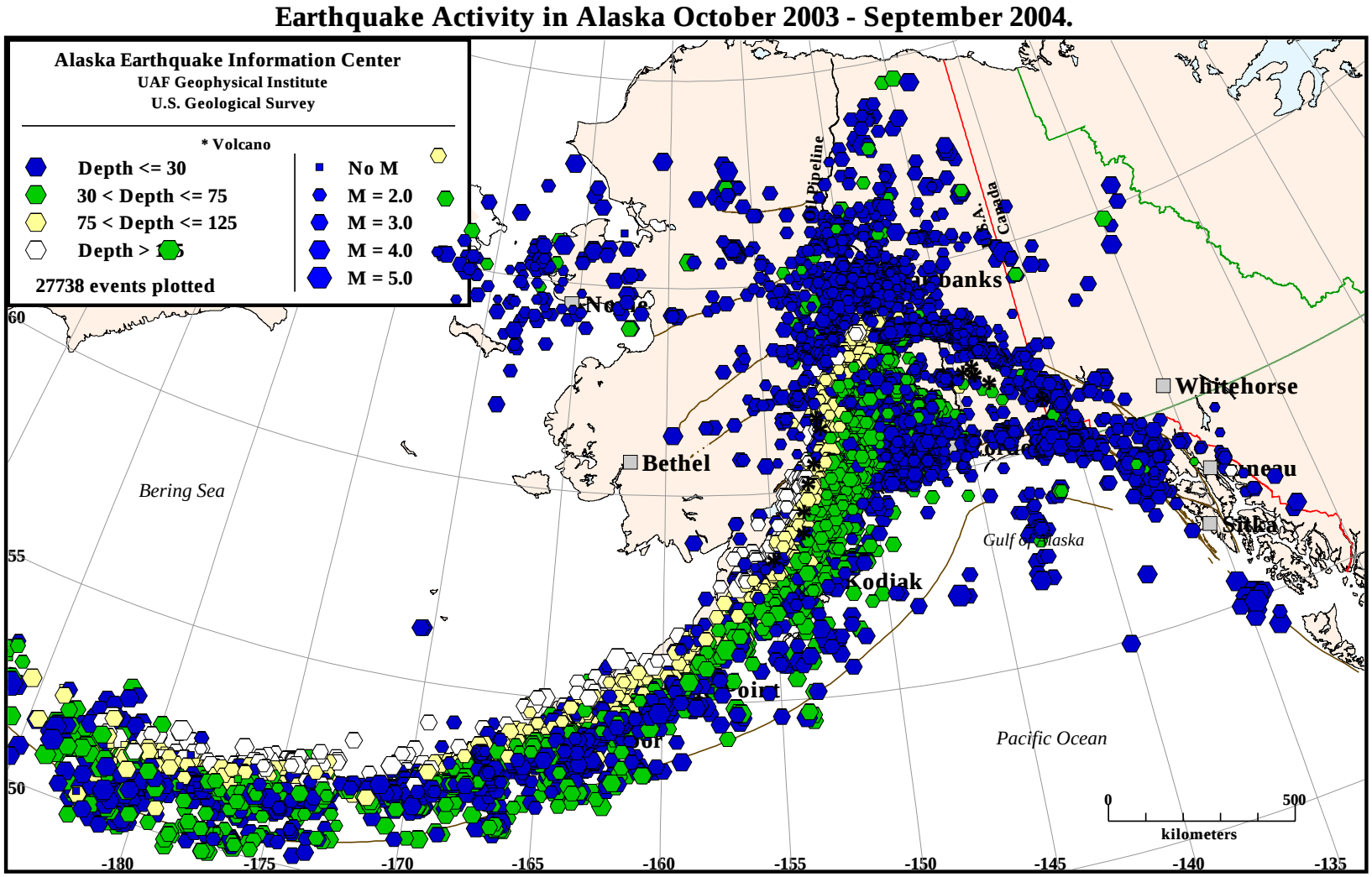

Figure 1. AEIC earthquake catalog from October 1, 2003 - September 30, 2004.

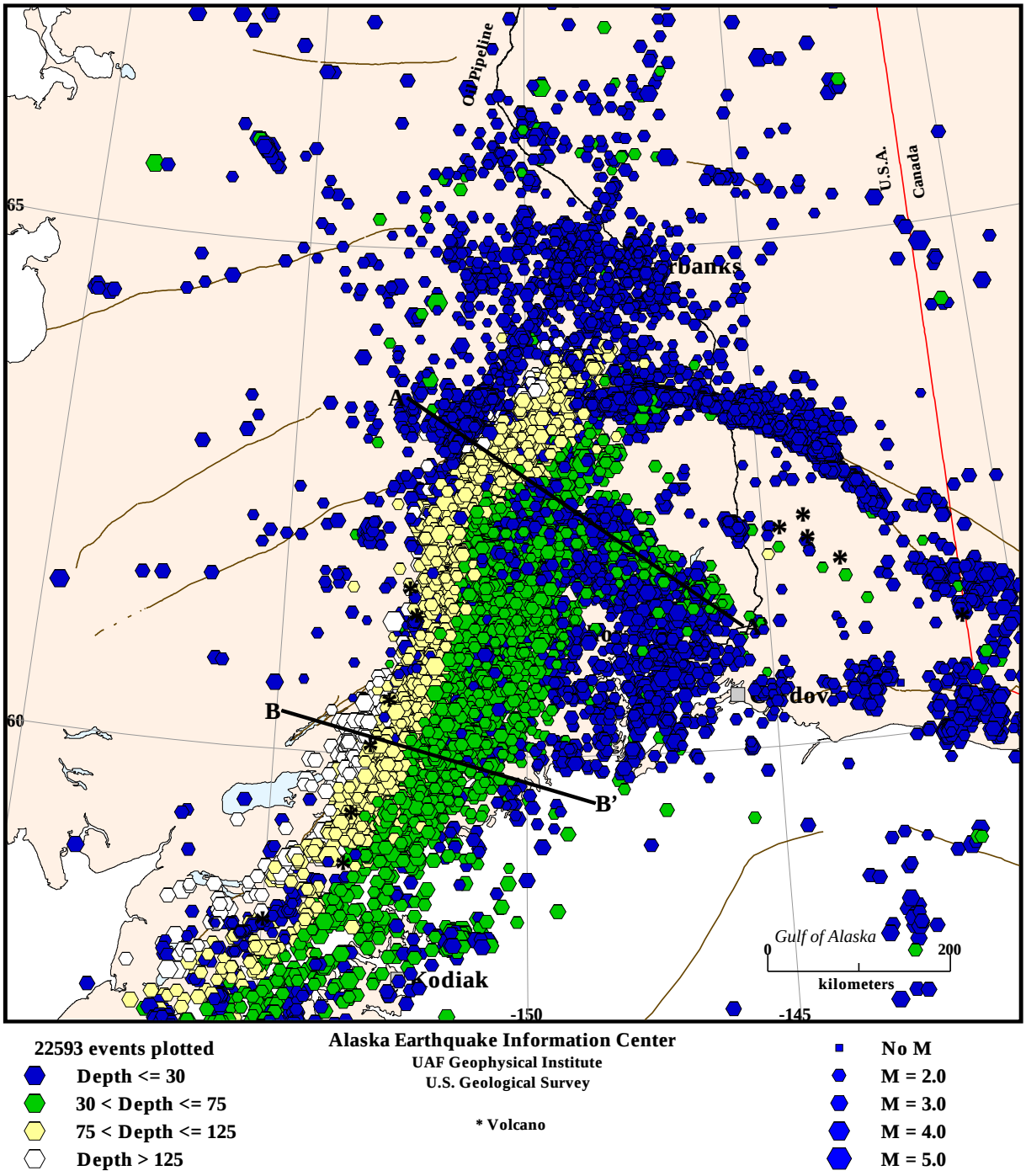

Figure 2a. The AEIC earthquake catalog for south-central Alaska October 1, 2003 - September 30, 2004.

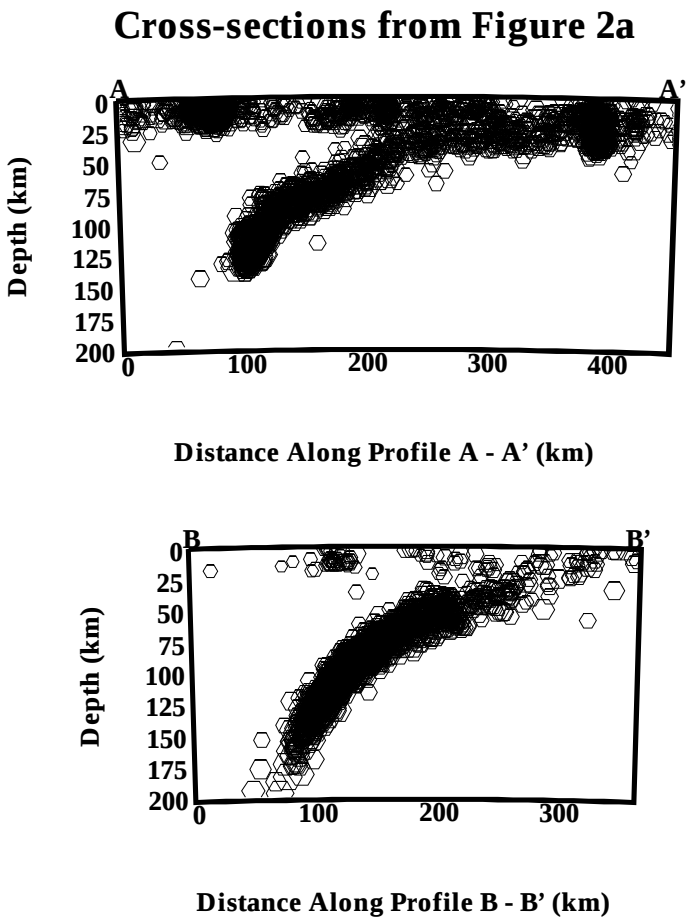

Figure 2b. Cross-sections from Figure 2a.

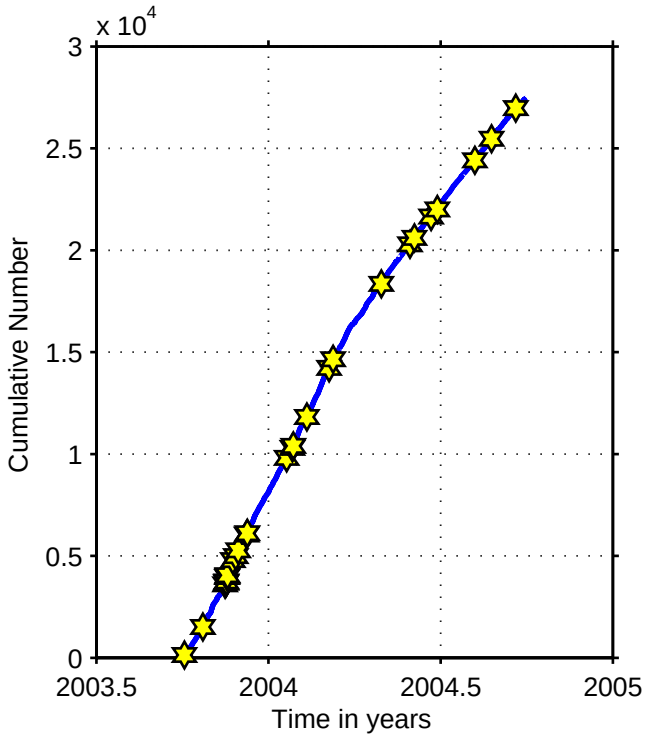

Figure 3. Cumulative plot of events from the AEIC earthquake catalog from October 1, 2003 - September 30, 2004. Starts are events with the magnitudes 5.0 and larger.

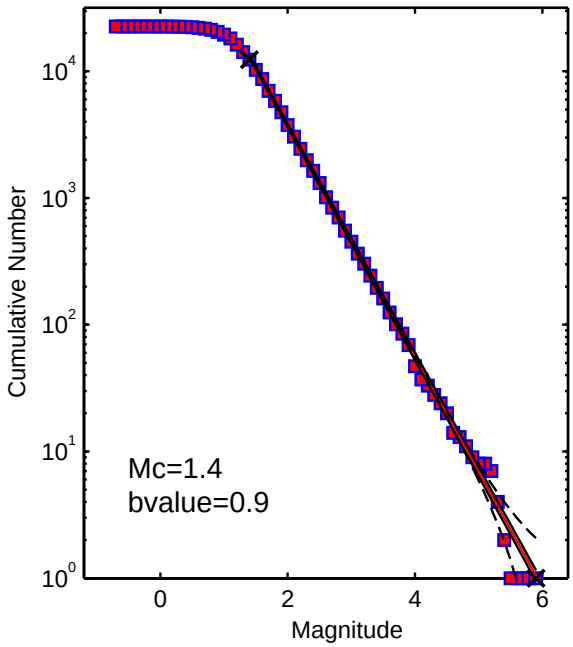

Figure 4. Frequency-magnitude plot for the mainland Alaskan events from the AEIC earthquake catalog from October 1, 2003 - September 30, 2004. Estimated magnitude of completeness is 1.4

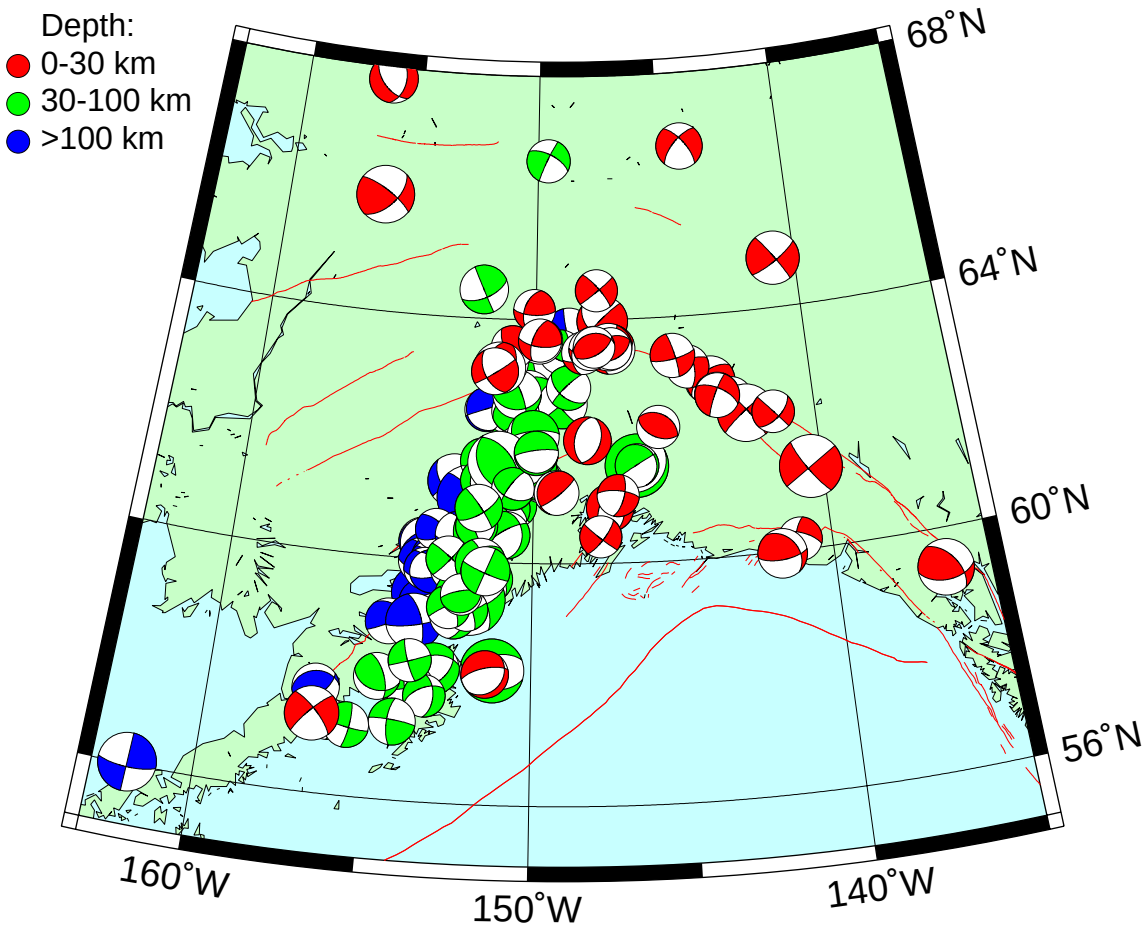

Figure 5a. P-wave first motion focal mechanisms from the AEIC earthquake catalog (October, 2003-September, 2004).

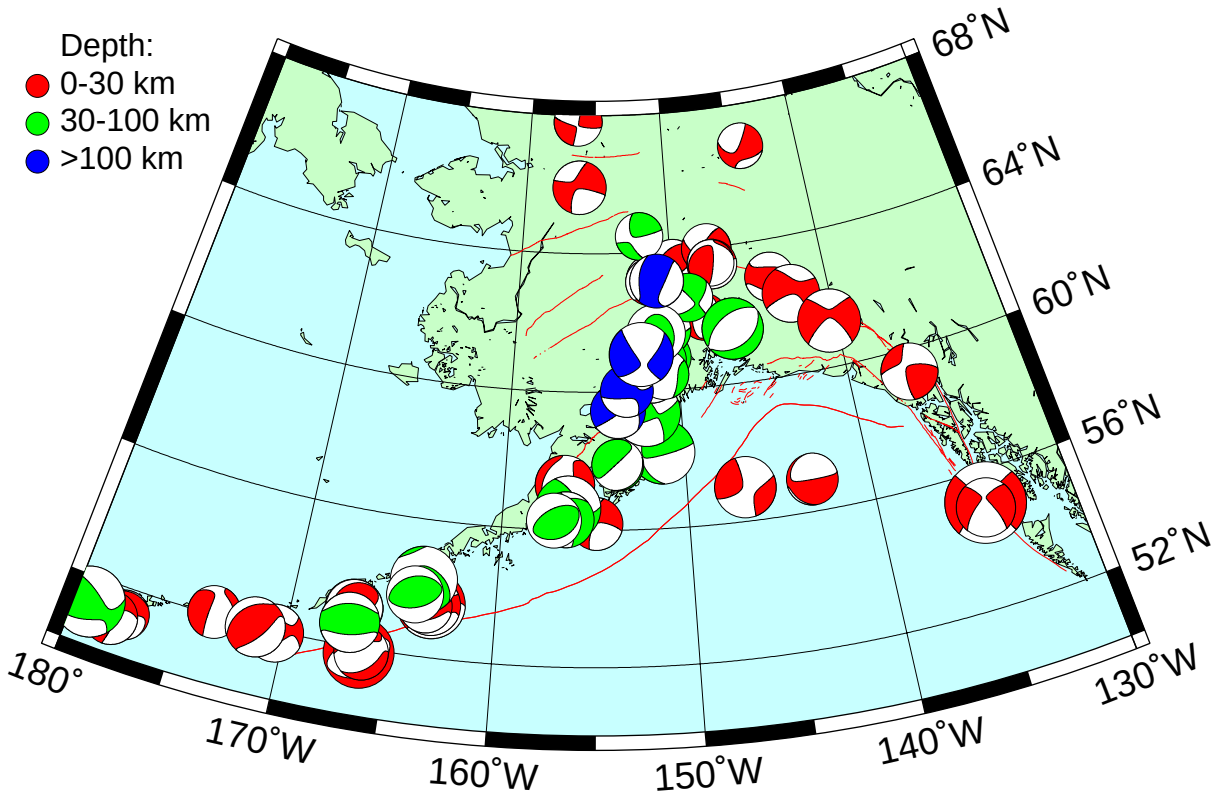

Figure 5b. Regional moment tensors from the AEIC earthquake catalog (October, 2003-September, 2004).